REMARKS

The Applicants respectfully request further examination and reconsideration in view of the amendments above and the remarks below. Previously, claims 1-32 were pending in the application, of those claims 1-32 were rejected. By the above amendments, claims 1, 2, 5, 12, and 21 are amended. Claims 8, 14-19, and 22-25 are withdrawn. Accordingly, claims 1-32 are still pending.

Restriction Requirement and Election of Species

The Examiner issued a Restriction Requirement indicating that species A and B are directed to distinct inventions. The Examiner also indicates that once either species A or N is elected, the Applicant is further required to elect between the patentably distinct species C-J.

The Applicants elect species A and species H without traverse. Therefore, the Applicants elect examination to claims 1-7, 9-13, 20-21, and 26-32. Claims 8, 14-19, and 22-25 are withdrawn.

The Applicants expressly reserve the right to file one or more divisional applications directed toward the non-elected species.

Claim Objections

Within the Office Action, claim 1 is objected to because the recitation "wherein the fluid and gas" lack antecedent basis. By the above amendments, claim 1 is amended to include the limitation "wherein the fluid and a gas."

Within the Office Action, claims 1 and 12 are objected to because the recitation of "the system", "a cooling system", and "a sealed cooling system" creates ambiguity. By the above amendments, claims 1 and 12 are each amended to consistently include the recitation "the sealed cooling system."

Claim Rejections Under 35 USC §112

Within the Office Action, claim 3 is rejected under 35 U.S.C. 112, first paragraph. In particular, the Examiner contends that the present application distinctly discloses two methods of cooling a heat generating device, one method directed to adjusting operation of a pump to adjust fluid flow or adjusting operation of an orifice to adjust fluid flow, and that each of the methods is disclosed as an alternative, not a combination. The Applicant disagrees with this interpretation of the present application. However, for reasons other than overcoming this rejection, the independent claim 1 is

amended such that the inclusion of the subject matter of the dependent claim 3 does not result in a combination of the aforementioned two methods.

Within the Office Action, claims 5 and 21 are rejected under 35 U.S.C. 112, second paragraph. In particular, claim 5 is rejected because the recitation "a larger volume" is unclear. By the above amendments, the limitation "a larger volume" is changed to --a volume--. Claim 21 is rejected because the recitation "wherein the inorganic is selected from the group consisting of ammonia and carbon dioxide" is indefinite. By the above amendments, claim 21 is amended such that its dependency is changed to depend on claim 1, and the limitation "wherein the inorganic is selected from the group consisting of ammonia and carbon dioxide" is changed to --"wherein the fluid is selected from the group consisting of ammonia and carbon dioxide--.

Claim Rejections Under 35 USC §102

Within the Office Action, claims 1, 4-7, 9-11, and 31-32 stand rejected in view of U.S. Patent Publication 2004/0089008 issued to Tilton et al. (hereafter "Tilton"). The Applicant respectfully traverses this rejection.

Tilton teaches a spray cooling system 10 including a heat exchanging unit 20 and a spray module 50. The spray module is coupled to a semiconductor 12. The heat exchanging unit 20 is coupled to the spray module 50 via a coaxial tube 60 and a coupler unit 70. The heat exchanging unit 20 includes a pump 40, a coolant reservoir 25, and an air chamber 29. Coolant is pumped through the heat exchanging unit 20 such that heat coolant and vapor is received from the spray module 50. The reservoir 25 is fluidly connected to th the air chamber 29 via air passage 25' for allowing air and other gases within the reservoir 25 to pass upwardly within the coolant through the air passage 25' into the air chamber 29 (Tilton, [0057]). The system also includes a pressure relief valve 42 within an upper portion of the air chamber 29 for allowing periodic releases of the collected air and non-condensable gases from within the air chamber 29 (Tilton, Figures 5 and 6, [0058]).

Within the Office Action, the Examiner contends that the spray cooling system 10 is the same as the claimed sealed cooling system because the spray cooling system 10 is "interpreted as a closed cycle, wherein the refrigerant is substantially closed from the environment" and that "the coolant is re-circulated and both phases are retained within the cooling system 10." However, this conclusion is not consistent with the teachings of Tilton, and does not read on the claimed limitations. Specifically, the independent claim 1 includes the limitation "wherein the fluid and <u>a gas</u> generated from boiling <u>remain sealed within the sealed cooling system</u>" (emphasis added). Additionally, Tilton specifically teaches a

pressure relief valve 42 for allowing periodic releases of the collected air. Clearly, the collected air of Tilton does not remain sealed within the cooling system 10, as claimed. For at least this reason, claim 1 is allowable over Tilton.

Claims 4-7, 9-11, and 31-32 depend from claim 1, which is allowable over Tilton for the reasons presented above. Thus, claims 4-7, 9-11, and 31-32 are allowable as being dependent from an allowable base claim.

Within the Office Action, claims 1, 4-7, 9-11, and 31-32 stand rejected in view of U.S. Patent Application 6,836,131 issued to Cader et al. (hereafter "Cader"). The Applicant respectfully traverses this rejection.

Cader teaches cooling a heat spreader 617 by using spray heads 615 within a spray chamber 625 to inject fluid onto the heat spreader 617. The coolant delivery pressure of the fluid injected by the spray heads 615 is controlled by a pump 665 (Cader, col. 9, lines 27-29; col. 8 lines 13-14). However, the coolant delivery pressure is not the same as the pressure within the spray chamber 625, and it is the pressure within the spray chamber 625 that determines the boiling point temperature of the fluid. Cader teaches that the pressure within the spray chamber 625 is regulated by the solenoid valve 685 (Cader, col. 9, lines 29-32).

Cader also teaches that the controller 600 controls the cooling rate of the device under test (DUT) by adjusting either "the flow rate of the coolant, the temperature of the coolant, **or** change the pressure in the chamber so as to change the boiling point of the cooling liquid" (emphasis added). As described above, Cader teaches changing the pressure in the spray chamber 625 by adjusting the solenoid valve 685. Cader teaches adjusting the flow rate of the coolant to adjust the coolant delivery pressure, and therefore the injection pressure of the coolant injected by the spray heads 615. However, the injection pressure does not control the pressure within the spray chamber 625. Cader does not teach adjusting the flow rate to adjust the pressure within the spray chamber.

The independent claim 1 includes the limitation "adjusting a pressure of the flowing fluid to correspondingly adjust a boiling point temperature of the fluid in the at least one heat exchanger" and "the pressure of the flowing fluid is adjusted by dynamically adjusting a fluid flow rate in the at least one heat exchanger." Cader teaches adjusting the pressure at the heat spreader by adjusting a gas relief valve. Cader also teaches adjusting fluid flow rate to adjust a coolant delivery pressure as applied by spray heads. Cader does not teach adjusting the flow rate to adjust the pressure within the spray chamber. For at least these reasons, claim 1 is allowable over Cader.

Claims 4-7, 9-11, and 31-32 depend from claim 1, which is allowable over Cader for the reasons presented above. Thus, claims 4-7, 9-11, and 31-32 are allowable as being dependent from an allowable base claim.

Within the Office Action, claims 1, 20, and 26-32 stand rejected in view of over "Modeling of Two-Phase Microchannel Heat Sinks for VLSI Chips" by Koo et al.(hereafter "Koo"). The Applicant respectfully traverses this rejection.

Within the previous Office Action mailed on March 12, 2007 (hereafter "previous Office Action"), the Examiner acknowledged that Koo does not explicitly disclose adjusting the refrigerant's pressure in relation to the fluid's boiling temperature (previous Office Action, page 3). Also within the previous Office Action, the Examiner further acknowledges that Koo does not expressly disclose that the pressure of the refrigerating fluid is adjusted in the system by adjusting the operating conditions of the pump in response to the change in temperature of the fluid. Yet in the current Office Action, the Examiner contends that Koo now teaches both of these limitations. Specifically, the Examiner contends that Koo teaches a pump that adjusts pressure of the fluid, and that such pressure adjustment by the pump inherently changes the saturation temperature of the fluid.

Within the Background section of the present application, the Applicant details the problem of pressure drop within a two-phase microchannel heat exchanger (Present Specification, page 2, line 14 to page 3, line 4). Koo provides test data that supports the existence of pressure drop in a two-phase microchannel heat exchanger, in accordance with the problems detailed in the present application. Koo makes theoretical predictions and provides experimental data that supports those predictions as to the amount of pressure drop for two-phase flow. However, Koo does not provide a dynamic solution to the pressure drop problem. The Examiner cites the pressure drop versus power input graph of Figure 5 (Koo) as supporting the assertion that Koo teaches adjusting an operating condition of the pump in response to a changed property of the heat generating device. However, Koo makes no such conclusion. Koo specifically states that the graph of figure 5 shows data that supports the assertion that pressure drop is a function of applied heating power. Koo makes no assertion as to how this data is to be applied, and certainly does not teach any application by which the pump is dynamically adjusted in response to a changed condition of a heat generating device. It is in fact the Examiner that is taking the data provided by Koo and extrapolating an application of this data in hindsight of the claimed invention.

The curves shown in Figures 5-6, 8-9 of Koo provide performance data based on experimentation. Koo teaches designing a cooling system with a fixed applied power. The amount of

this power is determined according to the given mass flow rate and the performance data obtained in regard to Figures 8 and 9. Koo does not teach monitoring the properties of a heat generating device once the cooling system is past its initial design, and upon detecting a change in such properties, adjusting the pressure of the fluid according to the performance data obtained in regard to Figures 5-6, 8-9. In other words, Koo teaches the use of determined relationships between pressure, temperature, flow rate, and power to initially design a cooling system according to specified parameters. Koo does not teach using the relationships between pressure and temperature to dynamically adjust a fluid flow rate in response to changes in monitored parameters.

The independent claim 1 includes the limitation "adjusting a pressure of the flowing fluid to correspondingly adjust a boiling point temperature of the fluid in the at least one heat exchanger" and " the <u>pressure of the flowing fluid is adjusted</u> by <u>dynamically adjusting a fluid flow rate</u> in the at least one heat exchanger <u>in response to a changed property</u> of the heat-generating device or the cooling system" (emphasis added). Koo teaches the use of determined relationships between pressure, temperature, flow rate, and power to initially design a cooling system according to specified parameters. Koo does not teach using the relationships between pressure and temperature to dynamically adjust a fluid flow rate in response to changes in monitored parameters. For at least these reasons, claim 1 is allowable over Koo.

Claims 20 and 26-32 depend from claim 1, which is allowable over Koo for the reasons presented above. Thus, claims 20 and 26-32 are allowable as being dependent from an allowable base claim.

Within the Office Action, claims 1, 20, and 26-32 stand rejected in view of "A Closed-Loop Electroosmotic Microchannel Cooling System for VLSI Circuits" by Jiang et al. (hereafter "Jiang"). The Applicant respectfully traverses this rejection.

Similarly to Koo, Jiang provides test data that supports the existence of pressure drop in a two-phase microchannel heat exchanger, in accordance with the problems detailed in the present application. Jiang makes theoretical predictions and provides experimental data that supports those predictions as to the amount of pressure drop for two-phase flow. However, like Koo, Jiang does not provide a dynamic solution to the pressure drop problem. The Examiner cites the pressure drop versus power input versus chip temperature graph of Figure 12 (Jiang) as supporting the assertion that Jiang teaches adjusting an operating condition of the pump in response to a changed property of the heat generating device. However, Jiang makes no such conclusion. Jiang specifically states that the graph of

figure 12 shows test data as to the relationship between chip temperature and pressure drop with varying input power. Jiang provides a comparison between predictions and actual experimental data for the chip temperature rise and heat exchanger pressure drop as functions of the input power (Jiang, Figure 7). Based on this comparison, Jiang concludes that the model used to make the predictions is as a tool for design and optimization of heat exchangers (Jiang, page 8, middle paragraph). Jiang makes no assertions as to how this data can be applied to systems already including an existing heat exchanger. More specifically, Jiang does not teach any application that uses the relationships between pressure and temperature to dynamically adjust a fluid flow rate in response to changes in monitored parameters. Jiang teaches the use of determined relationships between pressure, temperature, and power to initially design a heat exchanger according to specified parameters.

For at least these reasons, claim 1 is allowable over Jiang. Claims 20 and 26-32 depend from claim 1, which is allowable over Jiang for the reasons presented above. Thus, claims 20 and 26-32 are allowable as being dependent from an allowable base claim.

Claim Rejections Under 35 USC §103

Within the Office Action, claim 13 stands rejected as being unpatentable over the obvious modifications of Cader. Claim 13 is dependent on the independent claim 1. Claim 1 is allowable for at least the reasons presented above. Thus, claim 13 is allowable as being dependent from an allowable base claim.

Within the Office Action, claim 21 stands rejected as being unpatentable over Jiang in view of U.S. Patent Publication 2004/0250994 to Chordia et al. (hereafter "Chordia"). Claim 21 is dependent on the independent claim 1. Claim 1 is allowable for at least the reasons presented above. Thus, claim 21 is allowable as being dependent from an allowable base claim.

For the reasons given above, the Applicant respectfully submits that the pending claims 1-32 are in a condition for allowance, and allowance at an early date would be appreciated. If the Examiner has any questions or comments, he is encouraged to call the undersigned at (408) 530-9700 so that any outstanding issues can be expeditiously resolved.

Respectfully submitted,
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